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Effect of seed polymer coating with micronutrients on seed quality of chickpea (*Cicer arietinum* L.)

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Abstract
The Laboratory experiment was carried out in the Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Raichur during *Rabi* season of 2014-15 with an objective to study the effect of seed polymer coating with micronutrients on seed quality of chickpea (*Cicer arietinum* L.). The experiment was laid out in a completely randomized design with seventeen treatments including control with four replications. The results revealed that, chickpea seeds treated with either combined application of 6 ml polymer per kg seed along with micronutrients namely, $ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each at 2 g per kg of seed or individual application of either ammonium molybdate (2 g/kg of seed) or $ZnSO_4$ (2 g/kg of seed) or $FeSO_4$ (2 g/kg of seed) or Boron (2 g/kg of seed) can used in order to enhance the seed quality in chickpea.

Keywords: Chickpea, polymer coating, micronutrients, seed quality

Introduction

Pulses play an important role in agriculture as they are the main source of proteins compared to other protein rich sources (meat and meat products). Among the pulses, Chickpea (*Cicer arietinum* L.) commonly known as Bengal gram is a major pulse crop, which is highly nutritious grain legume and one of the cheapest sources of energy, protein with soluble and insoluble fibre, in addition to this it also contains vitamin B, enriched 60-65 per cent carbohydrates, 6 per cent fat and 12 to 31 per cent higher protein than any other pulse crop (Anon., 2014) [3, 5]. This crop meets up to 80 per cent of the soils nitrogen needs through symbiotic nitrogen fixation, so farmers can apply less nitrogen fertilizer than they do for other non-legume crops. India is the largest producer of chickpea contributing over 70 per cent of the world production occupying an area of 86.80 lakh ha with a production of 80.90 lakh tonnes with 932 Kg per hectare productivity (Anon., 2017) [4]. The major chickpea growing states in India are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Andhra Pradesh and Karnataka.

Seed polymer is used for coating as a thin, uniform layer over the seeds without any significant increase in seed size or weight. The major benefits of using this seed polymer is that the seed enhancement materials (fungicides, microbiological agents and micronutrients) can be directly placed on to the seed which requires smaller amount of chemicals as compared to broadcasting or surface dressing. Seed coating is one of the most economical approaches for improving seed performance besides it has provoked the interest among many seed traders and seed companies, as it improves its marketability, brand identity and helps the farmers for easy identification of the crops and varieties based on colour. Modern seed technology provides a wide selection of enhancements that can be aimed at translating a variety's genetic potential into improved harvest and quality (Bharathi. A and Srinivasan. J. 2010) [8].

The continuous use of micronutrient free high nitrogen and phosphorous fertilizers in the intensive cropping system with diminishing use of organic manures has resulted in the depletion of micronutrients cations from the soil reserves. Owing to this, the productivity of many crops has reduced substantially over the years. It is estimated that, the extent of micronutrient deficiency in the Indian soils are 47, 35, 15, 13, 4 and 2 per cent for Zinc, Boron, Molybdenum, Iron, Manganese and Copper, respectively. While, in Karnataka it is 78, 39, 32 and 5 per cent for Zinc, Iron, Boron and Copper respectively (Anon., 2011) [2].

Micronutrients play an important role in increasing the yield levels and improving seed quality in pulses, oilseed and legumes through their direct effects on the plant and through symbiotic nitrogen fixation process. The micronutrients are required in relatively smaller quantities for plant growth and they are as important as macronutrients and often they act as co-factors in enzyme systems and participate in redox reactions, in addition to having several other vital functions in plants (Marschner, 1995; Mengel *et al.*, 2001) [22, 23].

Among the micronutrients zinc, boron, ferrous sulphate and ammonium molybdate are very important for chickpea. Zinc is involved in biosynthesis of plant hormone, in dole acetic acid (IAA), auxin metabolism and is component of variety of enzymes which plays an important role in nucleic acid and protein synthesis and helps in utilization of phosphorus and nitrogen in seed formation and development. The second phase of seed development requires adequate amount of zinc dependent upon auxin for seed development. Ferrous sulphate is an important constituent of chlorophyll biosynthesis, regulates respiration, photosynthesis, reduction of nitrates and sulphates, also activates several enzymes involved in respiration (Kaleeswari *et al.*, 2013) [18]. While, boron plays an important role in flower retention, pollen tube growth, seed formation and seed setting and mainly involved in translocation of metabolites from source to sink (Dell and Huang, 1997; Tanaka and Fujiwar, 2008) [11, 30]. Molybdenum is involved in nitrogen nutrition and its assimilation. In legumes, it helps root nodule bacteria to fix atmospheric nitrogen (Campo *et al.*, 2000) [9].

The micronutrients may be supplied to the plants through soil application, foliar spray or applied to seed through seed treatment. Although the required amount of micronutrients can be supplied by any of these methods, foliar sprays have been more effective in yield improvement and grain quality. Application of foliar sprays of micronutrients is taken up at later growth stages when crop stands are already established. Hence, an alternative acceptable method of supplying micronutrients during the early stage of seedling establishment is the need of the hour.

Micronutrient application through seed treatment improves the stand establishment, advances phenological events, increases yield and micronutrient contents in grain in most of the crops. In many cases, micronutrient application through seed treatment performed better or similar to other application methods (Singh *et al.*, 2003) [28]. Being an easy and cost effective method, micronutrient application through seed treatment by polymer coating offer an attractive option for resource-poor farmers (Johnson *et al.*, 2005) [17].

Keeping in view of the above aspects, the present investigation was taken up in chickpea with the following objective to study the effect of seed polymer coating with micronutrients on seed quality of chickpea

Materials and Methods

The Laboratory experiment was conducted in the Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Raichur. It constituted seventeen different treatments (including control) with four replications. The treatments were T_1: $ZnSO_4$ @ 2 g per kg of seed, T_2: $ZnSO_4$ @ 4 g per kg of seed, T_3: Boron @ 2 g per kg of seed, T_4: Boron @ 4 g per kg of seed, T_5: Ammonium molybdate @ 2 g per kg of seed, T_6: Ammonium molybdate @ 4 g per kg of seed, T_7: $FeSO_4$ @ 2 g per kg of seed, T_8: $FeSO_4$ @ 4 g per kg of seed, T_9: $T_1 + T_3$, T_{10}: $T_1 + T_5$, T_{11}: $T_1 + T_7$, T_{12}: $T_3 + T_5$, T_{13}: $T_3 + T_7$, T_{14}: $T_5 + T_7$, T_{15}: $T_1 + T_3 + T_5 + T_7$, T_{16}: Only polymer, T_{17}: Absolute control. The experiment was laid in completely randomized design for seed of different treatment combination treated with polymer along with micronutrients. The standardized dosage of polymer coating of 6 ml per kg of seed was used as per the findings of Shinde *et al.* (2015) [26] in chickpea.

Procedure for polymer coating of seeds: The polymer used in the present study was Disco Agro DC Red L-603 procured from Incotec Pvt. Ltd. Ahmedabad, Gujarat. The cleaned and graded seeds were coated with different micronutrients as per the treatments either individually or in combination with polymer @ 6 ml per kg of seed using rotary seed coating machine. Subsequently the seeds were air dried to bring back to original moisture content and then used for seed quality testing.

The Seed germination test was conducted as per ISTA (Anon., 2014) [3, 5], speed of germination was calculated as per Maguire, (1962) [21], shoot length, root length, seedling dry weight as per Evans and Bhatt (1977) [12], electrical conductivity of seed leachate as per Presley (1958) [24], seedling vigour index was worked out as per the formula given by Abdul-Baki and Anderson (1973) [1]. The data of the laboratory experiment were analyzed statistically by the procedure prescribed by Gomez and Gomez (2010) [13].

Results and Discussion

In the present study, combined application of micronutrients with polymer ($ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each @ 2 g per kg of seed) *i.e* T_{15} recorded significantly higher seed germination (98.25 %) compared to all other treatments and control (89.50 %). However, T_{15} was on par with T_5, T_1, T_7, T_3 with 98.00 per cent germination, T_{10} (97.00 %), T_9 (96.50 %), T_{11} (96.50 %), T_{12} (96.00 %), T_{13} (95.50 %) and T_{14} (94.00 %) (Table 1). The increase in seed germination due to combined application of polymer and micronutrients was probably due to a) the polymer might have helped in formation of proper and uniform layer around seed coat which might have helped in creating micro environment for seed germination, b) the presence of micronutrient in polymer might have entered the seed through uniform imbibition leading to trig ring of metabolic activity through activation of dehydrogenase and releasing addition enzymes required for germination. The micronutrients are necessary for biosynthesis of IAA, a growth regulator which is essential for normal enlargement of cells, in addition they are the constituents of amino acids from which proteins and enzymes are synthesized which are helpful in proper germination and improving the vigour of the seeds. Similarly, Sherin Sushan John (2003) [25] reported that maize seeds coated with polykote @ 3 g dissolved in 5 ml of water, imidachloprid @ 1 ml, DAP @ 30 g and micronutrient mixture @ 19.7 g per kg of seed recorded the highest germination, enhanced seedling growth and also recording 13.2 per cent increased seed yield over control. Similar response of micronutrients *viz.*, $ZnSO_4$ (0.2 %) + $MnSO_4$ (0.2 %) + Na_2MO_4 (0.1 %) on seed germination of blackgram was reported by Vijaya and Ponnuswamy (1998) [31].

Similarly, the combination of $ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each @ 2 g per kg of seed (T_{15}) recorded significantly higher speed of germination (19.02) compared to all other treatments and control (13.76) (Table 1).This might be due to the hydrophilic nature of the polymer that might have increased the imbibition rate and the presence of essential micronutrient which might have led to faster activation of cells and resulting in the enhanced mitochondrial activity and formation of high energy compounds and vital biomolecules that were available during the early phase of germination due to reduced imbibition damage by regulating the water uptake. The results are in confirmation with Handiganoor *et al.* (2016) in pigeonpea due to seed polymerization of micronutrients. Srimathi *et al.* (2007) [29] in green gram due to combined application of $MnSO_4$ hardening (100 ppm) and hardening with 1 per cent Prosopis leaf extract

+ pelleting with DAP (40 g) + $MnSO_4$ (100 mg) + $FeSO_4$ (100 mg) + ammonium molybdate (250 mg) per kg of seed and Harish Babu *et al.* (2005) in green gram seeds pelleted with micronutrient mixture (2 % Iron + 1% Manganese + 3 % Zinc + 0.5 % Boron).

Likewise, the combined application of $ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each @ 2 g per kg of seed (T_{15}) recorded significantly higher shoot and root length (18.37 and 23.15 cm, respectively) as compared to all other treatments and control (12.25 and 15.19 cm, respectively) (Table 1). This increased shoot and root length might be due to seed polymerization with micronutrients leading higher germination potential and seedling growth, this in turn might have increased the metabolic activity of indole acetic acid and auxin (Krishnasamy, 2003) [7, 20] through micronutrients and its translocation leading to early germination, cell division and elongation of cells leading increase in root and shoot length (Basaria Begam and Krishnasamy, 2003) [7, 20]. The results are in confirmation with Handiganoor *et al.* (2016) in pigeonpea due to seed polymerization of micronutrients. Similar results were also reported by Srimathi *et al*. (2007) [29] in green gram due to combined application of $MnSO_4$ hardening at the rate of 100 ppm and hardening with 1 per cent Prosopis leaf extract + pelleting with DAP (40 g) + $MnSO_4$ (100 mg) + $FeSO_4$ (100 mg) + Ammonium Molybdate (250 mg) per kg of seed.

Among the different treatments, the combined application of $ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each @ 2 g per kg of seed (T_{15}) recorded significantly higher seedling dry weight (518.00 mg) as compared to all other treatments and control (358.50 mg) (Table 1). This increase in seedling dry weight was due to better seedling length (root + shoot) and also due to enhanced lipid utilization through glyoxylate cycle, a primitive pathway leading to faster growth and development of seedling to reach autotrophic stage well in advance of others and enabling them to produce relatively more quantity of dry matter (Jayaraj, 1977; Shkolnik and Abdurashitov, S. A., 1958) [16, 27].

Seed polymer coating with micronutrients showed significant variations for seedling vigour index. Among the treatments, the combined application of $ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each @ 2 g per kg of seed (T_{15}) recorded significantly higher seedling vigour index (4080) compared to all other treatments and control (2461). However, T_{15} was on par with Ammonium molybdate @ 2 g per kg of seed (T_5) (3948), $ZnSO_4$ @ 2 g per kg of seed (T_1) (3804), $FeSO_4$ @ 2 g per kg of seed (T_7) (3742) and Boron @ 2 g per kg of seed (T_3) (3732) (Table 1). This increase in seedling vigour index might be due to higher root and shoot length and higher germination percentage. Similar results were also reported by Harish Babu *et al.*(2005) in green gram seeds pelleted with micronutrient mixture (2 % Iron + 1% Manganese + 3 % Zinc + 0.5 % Boron) and Srimathi *et al*. (2007) [29] in green gram due to hardening with $MnSO_4$ (100 ppm)+ hardening with 1 per cent Prosopis leaf extract + pelleting with DAP (40 g) + $MnSO_4$ (100 mg) + $FeSO_4$ (100 mg) + Ammonium Molybdate (250 mg) per kg seeds, Similarly Kavitha (2002) [19] in blackgram seeds hardened with prosopis leaf extract (1%) followed by pelleting with 40 g DAP + 100 mg $ZnSO_4$ + 100 mg $FeSO_4$ + 250 mg ammonium molybdate per kg of seed.

Table 1: Effect of seed polymer coating with micronutrients on seed quality parameters of chickpea

Treatments	Germination (%)	Speed of germination	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	Seedling vigour index
T_1	98.00	17.31	17.51	21.29	470.50	3804
T_2	92.00	15.63	13.24	18.94	401.75	2962
T_3	98.00	16.97	17.42	20.69	464.50	3732
T_4	91.00	15.10	12.81	18.63	399.75	2866
T_5	98.00	17.38	17.55	22.75	483.75	3948
T_6	93.50	15.82	13.29	19.04	424.50	3017
T_7	98.00	17.11	17.48	20.71	469.75	3742
T_8	91.50	15.62	13.21	18.91	400.25	2940
T_9	96.50	16.57	15.00	20.36	449.50	3414
T_{10}	97.00	16.57	15.03	20.42	450.50	3437
T_{11}	96.50	16.57	14.97	20.29	443.00	3403
T_{12}	96.00	16.48	14.95	20.27	443.00	3381
T_{13}	95.50	16.29	14.91	20.23	429.00	3350
T_{14}	94.00	16.04	14.88	20.19	425.25	3295
T_{15}	98.25	19.02	18.37	23.15	518.00	4080
T_{16}	90.50	14.72	12.58	17.62	368.50	2738
T_{17}	89.50	13.76	12.25	15.19	358.50	2461
MEAN	94.93	16.29	15.02	19.92	435.29	3328
Sem+_	1.54	0.43	0.38	1.11	21.03	123
C.D @ 1%	4.37	1.22	1.07	3.15	59.72	349

Legend: T_1: $ZnSO_4$ @ 2 g per kg of seed, **T_2:** $ZnSO_4$ @ 4 g per kg of seed, **T_3:** Boron @ 2 g per kg of seed,
T_4: Boron @ 4 g per kg of seed, **T_5:** Ammonium molybdate @ 2 g per kg of seed, **T_6:** Ammonium molybdate @ 4 g per kg of seed,
T_7: $FeSO_4$ @ 2 g per kg of seed, **T_8:** $FeSO_4$ @ 4 g per kg of seed, **T_9:** T_1 + T_3, T_{10}: T_1 + T_5,
T_{11}: T_1 + T_7, **T_{12}:** T_3 + T_5, **T_{13}:** T_3 + T_7,
T_{14}: T_5 + T_7, **T_{15}:** T_1 + T_3 + T_5 + T_7, **T_{16}:** Only polymer,
T_{17}: Absolute control.

Conclusion

Seeds polymer coating with 6 ml polymer per kg seed along with micronutrients namely, $ZnSO_4$ + Boron + Ammonium molybdate + $FeSO_4$ each at 2 g per kg of seed or individual application of either ammonium molybdate (2 g/kg of seed) or $ZnSO_4$ (2 g/kg of seed) or $FeSO_4$ (2 g/kg of seed) or Boron (2 g/kg of seed) can be used to enhance the seed quality in chickpea as they were on par with their combined application for most of the seed quality parameters analysed in our study.

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